Title: **Multi-Peril Loss Studies: A Comparative Approach to Assessing Vulnerability in the Caribbean**

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Hazards examined: Earthquakes, hurricanes and combined perils.

Study emphasis: Post-disaster recovery, mitigation and risk management strategies.

Summary: Offers a methodology for comparing annual levels of risk between regions in the Caribbean. This is accomplished through the use of probabilistic loss calculations which provide loss estimations for a variety of hazard return periods on varying spatial scales. Results of the probabilistic loss calculations are applied to the formulation of Average Annualized Loss (AAL) estimations, devised by integrating losses from various disaster scenarios (possessing varying return periods and event magnitudes). Annualized Loss Ratios (ALRs) are the ratios of the average annual losses to the exposure to the hazard. ALRs for different areas may then be compared allowing for identification of levels of relative risk among different study locations. Study results are used primarily to establish insurance premium rates and assess industry solvency.

Vulnerability Indicators: Annualized loss ratios for earthquake, hurricane, and combined perils examined at various geographic levels of resolution (e.g. zip code to island/territory)

Economic Development, Disaster Preparedness, Disaster Response and/or Disaster Reconstruction Application: Prioritizing post-disaster recovery resource needs for various areas, developing a region-wide mitigation plan, and prioritizing regional risk management strategies based on the severity of the risk(s) and the risk drivers.

Data Requirements: Probabilistic hurricane and earthquake hazard models (including historical event databases, geologic data, wind field models, and underlying geography); structural type and occupancy classification systems; hurricane and earthquake vulnerability models

Output: Probabilistic loss calculations can provide loss estimates for a variety of return periods (e.g. 100 year loss) and at various geographic levels of resolution (e.g. zip code, city, county/parish, island/territory). An occurrence exceeding probability (EP) loss function uses a suite of scenario events to estimate the annual probability of exceeding a certain dollar loss. The

Average Annualized Loss (AAL) is an annual estimate developed by integrating losses from scenario earthquakes and hurricanes with varying repeat times and event magnitudes. This parameter provides a basis to compare the annual level of risk between regions. Risk management decisions however, should be based not only on absolute losses but should also take into account the exposure of a region. To deal with this issue, an Annualized Loss Ratio (ALR) is developed as the ratio of the average annual loss and the exposure. This index provides a measure of the relative risk between regions and can be compared across different geographic units.

The Caribbean loss study first compares ALRs for different islands/territories. These values are based on aggregated assumptions about city-level risk on each island. This study looks at ALRs for earthquake and hurricane perils, as well as the combination of both perils. A standard unit of $1,000 of residential exposure is used throughout the study region for purposes of comparison. However, the exposure assumptions vary from island-to-island to account for local building type variations. Next, the study compares risk at a higher level of resolution (i.e. zip code) for one territory, Puerto Rico. A representative residential exposure data set is used for this analysis so that variations in exposure and population density can also be assessed.

Results of Application at Case Study Site: Loss studies are commonly conducted for insurance regulators and industry associations. These studies provide a comprehensive profile of the peril-related risk(s) to the insurance industry in a particular region, state, or country. The results are usually provided in the aggregate (i.e. for the whole industry) as well as by individual company. These studies are generally used to establish premium rates, and assess industry solvency.

The Caribbean loss study illustrates relative risk based on Caribbean basin-wide hurricane and earthquake models developed in 1998. The outputs helped assess and validate model results, and communicate model implications with insurance and reinsurance clients. The Puerto Rico loss study is representative of results from an extensive model validation effort undertaken in 1999 based on losses incurred in Puerto Rico following Hurricane Georges. It is also indicative of results from an industry-wide study performed for the Puerto Rico Department of Insurance (1995).

Lessons Learned: Disaster management and policy decisions are risk-driven and thus require risk-based information. Yet, very often the "disaster vulnerability problem" is based on an understanding of the *hazard* (e.g. the location and type of faulting/geology or wind field models and storm tracks), rather than the *risk* (which results from a combination of the hazard, population and building exposure, and their respective vulnerabilities). A region with a high hazard level is not a societal concern if there is no exposed population and infrastructure. Contrarily, a low hazard area can experience high losses if there is significant exposure. Further, between two regions with the same hazard and exposure, the one with older and more vulnerable structures will suffer much more damage in comparable events.

Probabilistic-based loss studies provide a sound, long-term valuation of risk, and provide a good foundation for risk management policy making and mitigation investment. Peril models used in probabilistic analyses are generally well-validated, and based on accepted scientific evidence. The methodology is robust and results are generally stable, often with quantifiable uncertainty. A

consistent and well-founded methodology provides decision makers with the means to measure the relative risk between perils, regions, and across different geographic units.